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Determining the Geometry and the Cosmological Parameters of the Universe through SZE Cluster Counts

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abstract We study Sunyaev-Zel'dovich Effect (SZE) cluster counts in different cosmologies. It is found that even without the full knowledge of the redshift distribution of SZE clusters, one can still readily distinguish a flat universe with a cosmological constant from an open universe. We divide clusters into a low redshift group (with redshift $z \leq 0.5$) and a high redshift group (with $z \geq 1$), and compute the ratio of $r = N(z \leq 0.5)/N(z \geq 1)$, where $N(z \leq 0.5)$ is the number of flux-limited (S_ν^{lim}) SZE clusters with $z \leq 0.5$ and $N(z \geq 1)$ is the number of flux-limited SZE clusters with $z \geq 1$. With about the same total number of SZE clusters $N(z \geq 0)$, the r value for a flat universe with a non-zero cosmological constant and that for an open universe occupy different regions in the $S_\nu^{lim} - r$ plot for the most likely cosmological parameters $0.25 \leq \Omega_0 \leq 0.35$ and $0.2 \leq \Gamma \leq 0.3$, where Ω_0 is the matter density parameter of the universe, and Γ is the shape parameter of the power spectrum of linear density fluctuations. Thus with a deep SZE cluster survey, the ratio r can reveal, independent of the normalization of the power spectrum, whether we are living in a low-density flat universe or in an open universe. Within the flat universe scenario, the SZE cluster-normalized σ_8 is studied, where σ_8 is the r.m.s. density fluctuation within the top-hat scale 8 Mpch^{-1} where h is the Hubble constant in units of 100 kms^{-1} Mpc^{-1}. A functional relation $\sigma_8 \propto \Omega_0^{-0.13}$ is found. Combined with the X-ray cluster-normalized $\sigma_8 \propto \Omega_0^{-0.52+0.13\Omega_0}$, one can put constraints on both Ω_0 and σ_8 simultaneously.